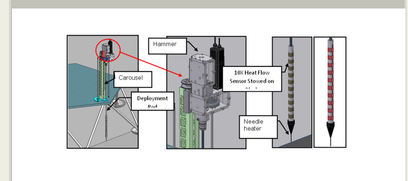
Lunar Heat Flow Probe, Phase I

Completed Technology Project (2015 - 2015)

Project Introduction

To accurately determine endogenic heat flow, both thermal gradient and thermal conductivity measurements are needed. The thermal gradient measurement can be achieved by using several temperature sensors equally spaced along the length of the probe. Thermal conductivity can be measured by one of two methods: the 'steady state' method or the 'transient with a variant' or 'pulse heating' method. The steady state method was used by the Apollo 15-17 missions , whereas the pulse heating method was developed by Lister (1979) after the Apollo period In the steady state heating method, heat is applied to the regolith around the probe for a long period of time and thermal conductivity is derived from the rate at which temperature rises. This will affect the measurement associated with the diurnal and annual wave as it adds a significant amount of heat to the regolith, which will take a very long time to dissipate. In the pulse heating method, more heat is applied for a short duration of time. The temperature of the probe increases instantaneously and slowly falls off as the heat dissipates into the regolith after the heater is turned off. In this case, the thermal conductivity is derived from the cooling rate. In the pulse heating method, less heat is required and less time is required for a measurement. For the most accurate results, sensors must extend below the depth of the multi-year thermal fluctuation detected during the Apollo missions (>3 m). If the hole is deep enough to avoid the effects of the insolation, the geothermal gradient obtained in a lower portion of the hole should accurately reflect the endogenic heat flow. The spacing between sensors should be small (approximately 30 cm), because thermal conductivity of the regolith is heavily affected by its texture, which varies with depth. Determining the in situ heat flow, as well as the site-specific thermal wave depths, requires that measurements be taken over long durations (6-8 years).



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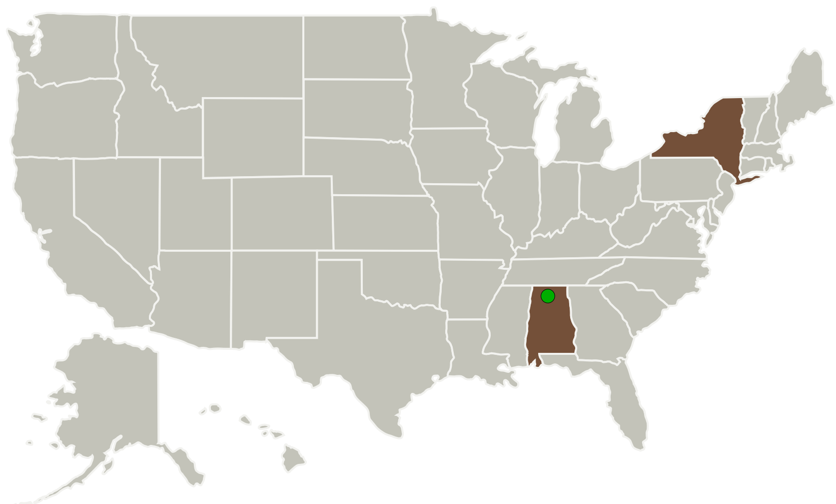
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Honeybee Robotics, Ltd.	Lead Organization	Industry	Pasadena, California
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	New York

Project Transitions

June 2015: Project Start

December 2015: Closed out

Closeout Summary: Lunar Heat Flow Probe, Phase I Project Image

Closeout Documentation:
- Final Summary Chart Image*(https://techport.nasa.gov/file/139193)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Honeybee Robotics, Ltd.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

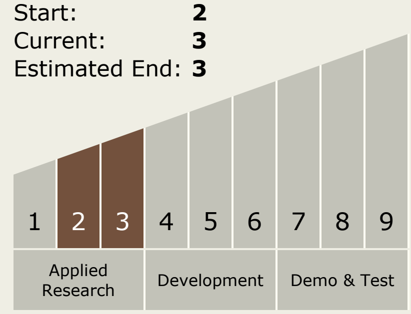
Carlos Torrez

Principal Investigator:

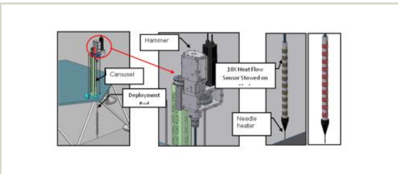
Kris Zacny

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Images



Briefing Chart Image
Lunar Heat Flow Probe, Phase I
(https://techport.nasa.gov/image/132905)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.3 In-Situ Instruments and Sensors
    └ TX08.3.4 Environment Sensors

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System